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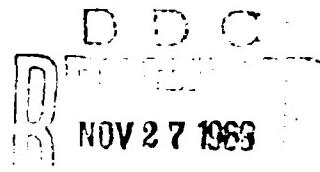
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RICE-BLAST (PIRICULARIOSIS) EPIDEMIC IN FRANCE IN 1959

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des Riziculteurs de France
(Reprint from the Information
Bullietin of the Rice-Growers
of France) No.63,1959,p.1-8.

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Research Center for
Southern France,
Montpellier.

Rice-growers have been alerted, on numerous occasions, to the possibility that certain epidemic diseases of rice might be introduced into Camargue (an area in the Rhone Delta). I have also stressed that some of them may be dangerous, especially when originating from seed produced in Italy. (1)

Since 1950, thanks to the surveys of Mr. Cotte, who is at present a professor at the National School of Agriculture at Montpellier, we were able to identify rice-blast disease, caused by Piricularia oryzae, especially on the variety "Martelli."

(1) P. Bernaux. 1950. Extension au Midi mediterraneen de trois maladies cryptogamiques (entre autres: Piricularia oryzae) (Spread of three cryptogamic diseases, incl. Piricularia oryzae, in the Mediterranean South of France). Prog. Agric. et Viticole, Sept. 30, 1950, p. 208-214, col. pl.

1951. Compte rendu d'une tournée pathologique dans les rizières (Report on a pathological infection of rice fields). Bull. Inf. Rizic. France, No. 17, Nov. 1951, p. 11-13.

1956. La piriculariose du riz en France (Rice-blast in France). "Riz et Riziculture" (Rice and Rice Cultivation), 2nd Yearbook, 1956, p. 217-221, 4 figs.

Every year thereafter small foci were found on various varieties of rice. However, the disease did not spread, probably because of unfavorable meteorological conditions. Suddenly, in 1959, climatic conditions produced an epidemic of rice-blast which spread with great rapidity.

In surveys made during August and September of 1959, we were able to determine the area infected and to follow the spread of *Piriculariopsis* (rice-blast). Simultaneously, we were also able to estimate the extent of the devastation and the losses produced in the rice fields. The losses were due to the partial or total burning of the panicle, accompanied by the formation of small, chalky kernels which had a reduced commercial value.

PATHOGENESIS

On August 15-18, the first symptoms of the disease appeared in the rice fields in the form of more or less distinctive brown patches from which the disease spread out. Enclosed, cultivated fields were only rarely completely diseased. More often, within these cultivated enclosures one could find these patches wherever there was an excess of nitrogen fertilizer. For example, excess nitrogen fertilization occurred in places where fertilizer bags had been dumped on the ground or where a fertilizer spreader had made several passes, such as in the corners (Fig. 2) or where excessive amounts of nitrogen fertilizer had been used. (Fig. 1)

The disease spread from such areas. Diseased leaves of the plants showed the characteristic spots of the attack by *Piricularia* (Fig. 5) which we have already described earlier: there is a grey central spot, surrounded by a brown border and yellow halo, corresponding to the growth of the mold. The diseased plants have a burnt appearance, no panicle or a panicle without kernels (Fig. 3). They remain stunted and form gaps in the rice field (Fig. 4). Moderately diseased plants formed a panicle.

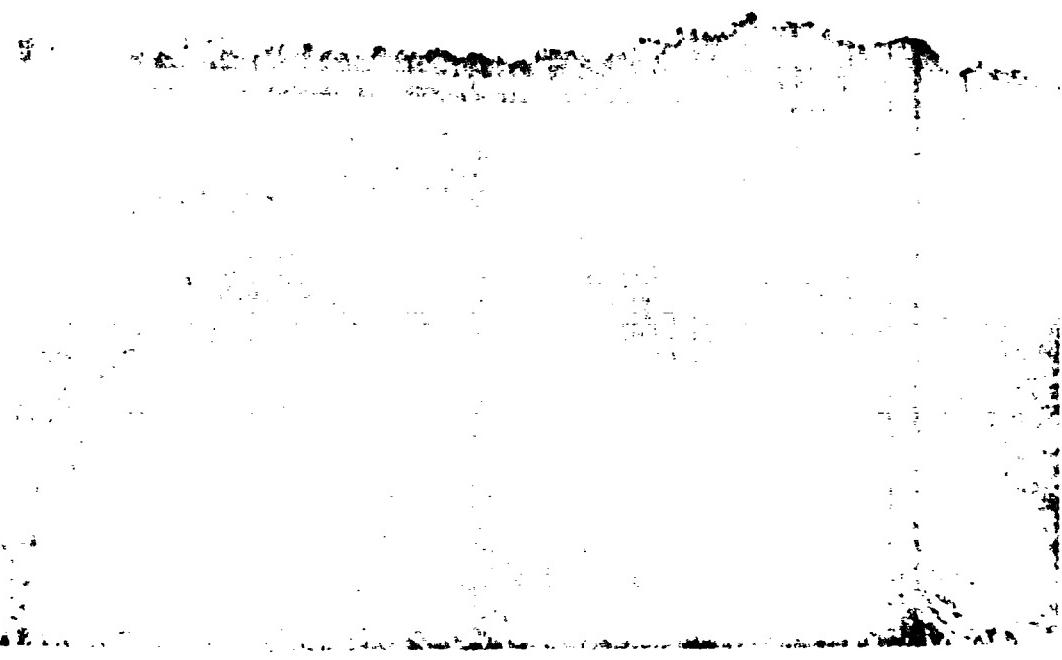


Fig. 1. Rice field showing a brown area of rice-blast, caused by a strong attack by Hiricularia. Located along the border of a field. It may have been caused by dumping sacks of fertilizer on the ground.

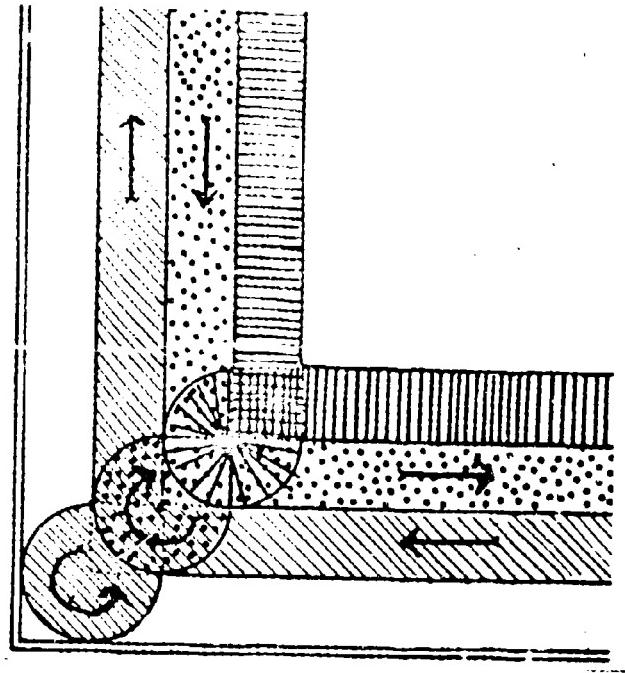


Fig. 2. Drawing of the traffic pattern made by a fertilizer spreader. Certain areas received an excess of fertilizer because of the repeated passes made by the spreader. This practice, which is not general, but which exists in many places, is recommended.

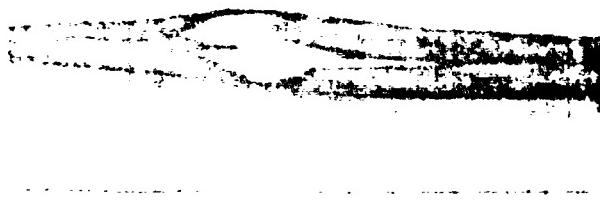


Fig. 5. Characteristic spot of Piricularia on a rice leaf. There is a greyish-whitish central area, surrounded by a brown border. The spots have different shapes. Some are elongated along the ribs of the leaf; others are confluent.



Fig. 3. Two panicles of the rice variety "Rinaldo-Bersani" (R.B.). Left: brown panicle of a plant killed by rice-blast; glumes are present, but without kernels. Right: healthy panicle.

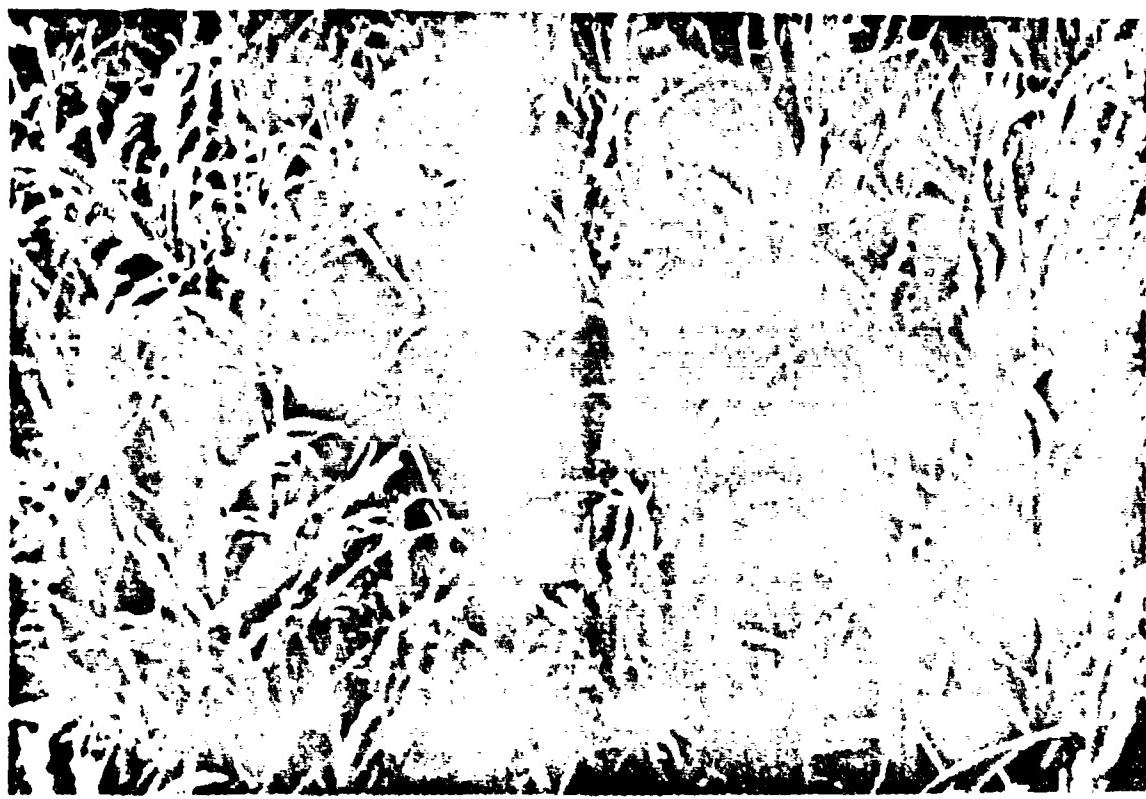


Fig. 4. A "gap" in a field produced by an attack of rice-blast by Piricularia. Diseased plants remain stunted and are overgrown by adjacent healthy plants.

The disease is equally noticeable at the neck and base of the panicle (Fig. 6) where the tissue has turned brown and necrotic. Eventually, the entire panicle assumes a "burnt" appearance and the underdeveloped kernels become chalky. Finally, the panicle turns grey because it is overgrown by saprophytic molds, e.g. Alternaria, Hemicoccum, etc.



Fig. 6. Infected panicle. The rachis has turned brown and the portion above it has dried out.

The panicle may be only partly "burnt", when the attack of the pathogen remains localized on the branches of the panicle. Eventually, the glumes become infected (Fig. 7) and show brown spots with a grey center: this symptom is of the utmost importance for the transmission of the disease.

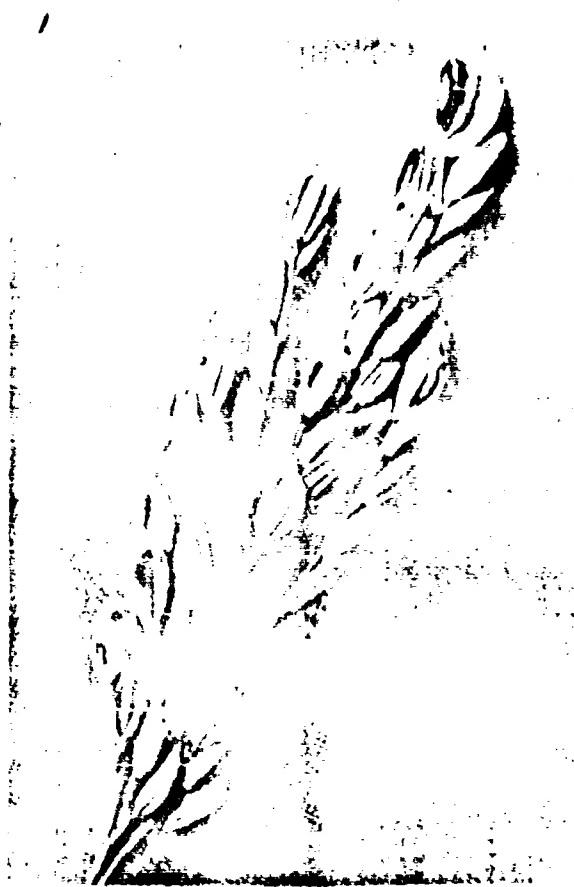


Fig. 7. Slow infection of a panicle. Typical spots of rice-blast can be seen on some areas of the panicle; on other areas there are small spots, pink droplets, which are a flaw and the blast.

THE PATHOGEN

On many occasions and in many different, infected regions we have found the fructifying conidia of the mold Piricularia oryzae, the causative organism of rice-blast.

This mold occurs wherever rice is cultivated and causes total devastations whenever meteorological conditions favor its spread. All aerial portions of the plant are attacked. The mold is aerobic and does not grow below the surface of water. It is capable of producing some damage to seedlings, when the kernel and young plant are in the mud, but only when the temperature is sufficiently high. In our regions, the temperature is rarely sufficiently high at seeding time.

The mold acts by releasing a toxin, piricularin, which increases the polyphenol content of the plants. These polyphenols reduce growth and respiration. Their presence is a serious complication during an early attack.

Piricularia overwinters either as conidia, produced on all parts of the infected rice plant, or as mycelium on straw and glumes. Also, conidia can survive -10°C.

CONDITIONS FAVORING EPIDEMICS

1) Origin of the Disease

As stated earlier, the disease has existed for many years. It was probably introduced into France by Italian seed. This seed was imported in the absence of any controls or seed-treatments. Yearly introductions of diseased seed maintained the supply of the mold. It is apparent from this that some concern ought to exist for controlling and treating seeds, or, better yet, that we produce a sufficient quantity of seed whose sanitary condition can be rigorously controlled.

Diseased straw, conidia and infected wild plants serve to perpetuate the disease.

2) Meteorological Factors

The mold depends for its development simultaneously on temperature and humidity. Both factors must be sufficiently high. A temperature of 24°-28° C and an atmospheric humidity above 90% for 16-24 hours favor infections. In a warm (20°-25° C) and dry atmosphere, Piricularia produces only insignificant localized infections, while in humid weather the lesions assume their typical appearance. We are showing in Fig. 8

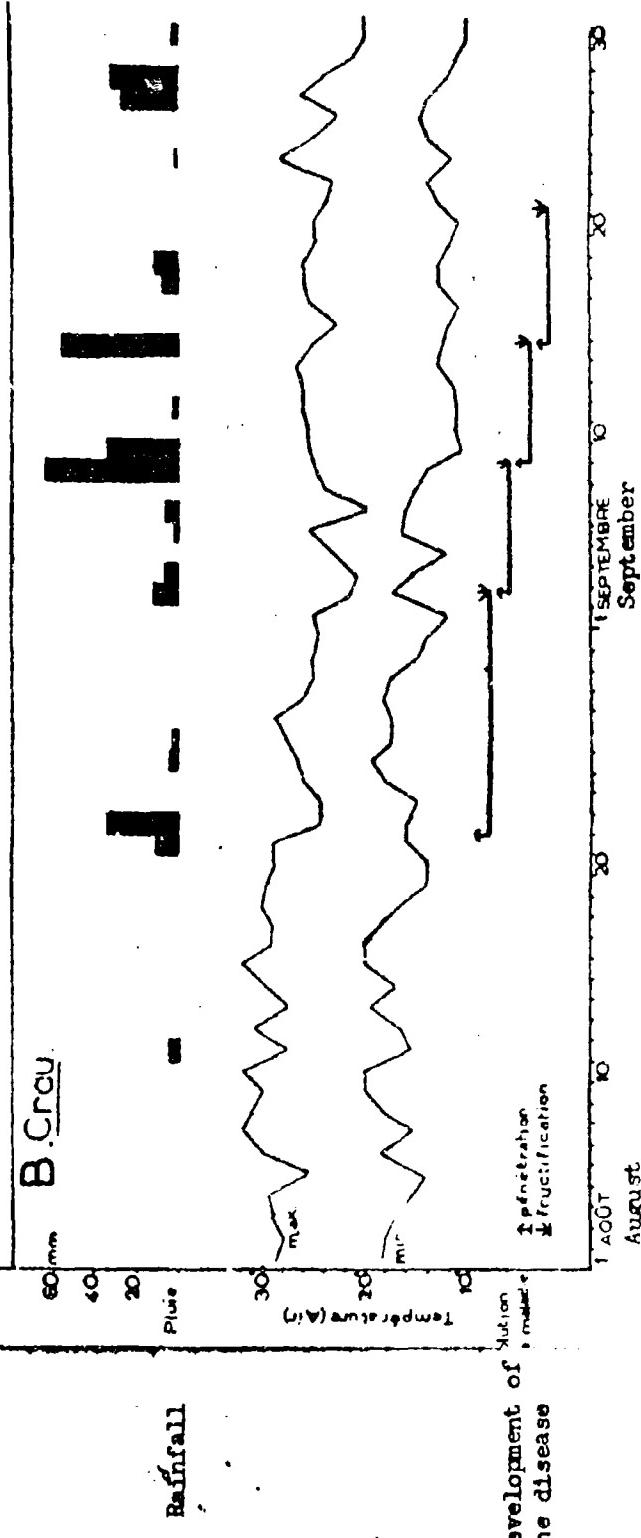
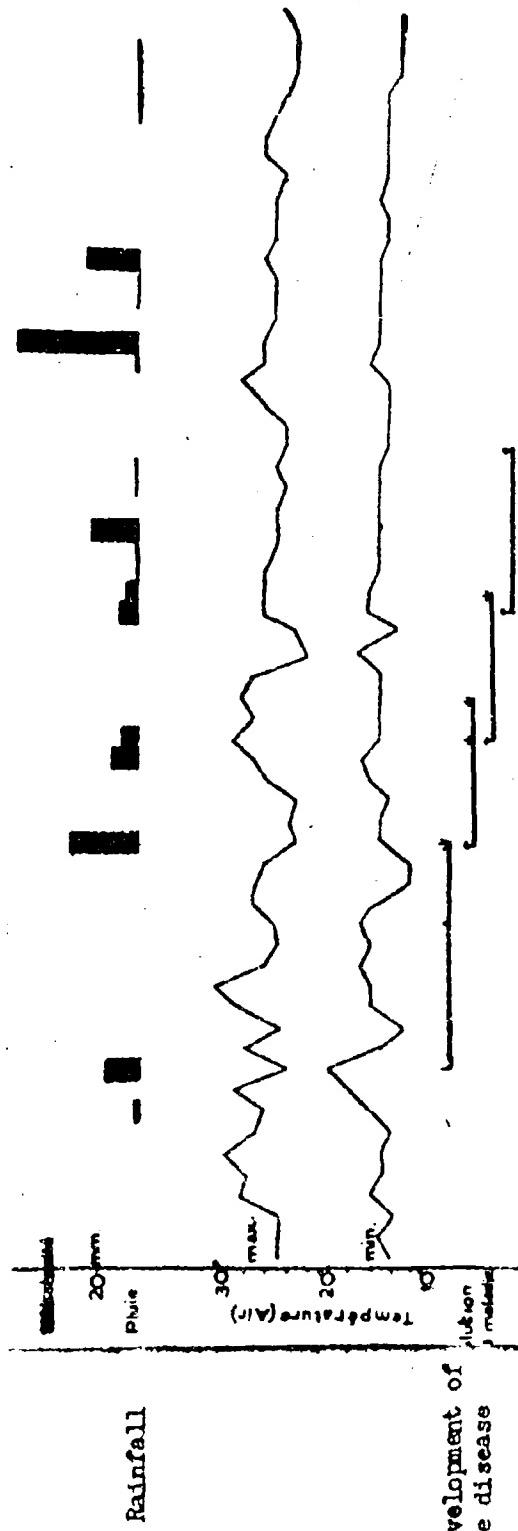


Fig. 8. Curves showing the development of rice-blast as a function of meteorological factors. A. Camargue. Peaks of the disease attained in special zones. G. Crau. Station at Le Merle. This area has a dryer atmosphere. The development of the disease is slower and delayed.

meteorological data from two stations at which the spread of rice-blast was different. Station A in Southern Camargue is located in an area where the epidemic was very serious. Station B in Crau at Le Merle is located in a dryer area.

At Station A we observed, particularly, that symptoms of rice-blast appeared on August 18, eight days after a rainfall of 16 mm on August 10. The minimum temperature was relatively high. After the first appearance of the disease, there occurred another rainfall of 33 mm on August 21, followed by three days of fog and reduced sunshine. During this time the plants were constantly soaked. Then came more rains (12 mm and 8 mm) which were accompanied by relatively high night temperatures.

At Station B, Le Merle in Crau, the first rainfall which fostered the growth of the mold did not appear until August 21 and 22. On those days, infection started, but because of the dryness of the atmosphere over Crau, fructification of the spots did not take place until the September rains of September 2, 6, 8, and 9. These rains allowed the infection to spread, but to a lesser extent in this area, because of the lower night temperatures.

3) Edaphic Environment

We stated above that the damage was more spectacular in those areas where excessive amounts of nitrogen fertilizer had been applied: where fertilizer had been dumped on the ground, where a spreader had made several passes over the same area, i.e. in the corners of a field. Borders, fertilized with green manures, benefitted because of the destruction of weeds along the slopes of the enclosures. The mold always developed in nitrogen-fertilized fields. There, the plants were greener, the epidermis was thinner and filled with water. All of this increased the plant's susceptibility to rice-blast.

As a general rule, it seems to be true that the amounts of nitrogen applied to rice are always excessive and always larger than the amounts recommended by the Research Service. Also, rice-growers often apply a minimum of 140 nitrogen units per hectare. Yet, the experiments performed by the Agronomy Research Service at Montfavet and Montpellier indicated that 100 nitrogen units per hectare sufficed. This is especially true because of the additional nitrification produced by prior crops.

In support of this recommendation and in relation to the disease we are studying, we have observed that, side by side, fields which received 140 nitrogen units of fertilizer were severely infected by rice-blast (50%

or more), while fields which had received only 100 nitrogen units were only lightly infected (10%). This indicates it is more sensible to apply only a reasonable amount of nitrogen, not to mention the economic benefits involved.

4) Growth of the Plant

The growth phase of the rice plant definitely influences the symptoms of the disease which is always related to climatic conditions.

The time of the salmon run (*montaison*) is particularly favorable for the spread of rice-blast. This is the time when most rice varieties reach a phase in their growth which is also favorable for the growth of the mold, because of the prevailing high temperatures and humidity of the region. We wish to stress the point that early varieties form panicles before the August rains and these early varieties are precisely the ones that develop spots of rice-blast on the panicle.

Emerged leaves are always susceptible. Adult leaves are equally easily attacked, because it is their edge which remains susceptible. Wounds caused by wind, i.e. wounds produced by rubbing, also favor rice-blast disease.

The infection often occurs at the base of the leaf and the stem becomes easily infected at that level. It is likely that the point of infection is related to the frequency with which water accumulates at that point. The infection is also related to the silica content of the leaves. Silica, combined with various constituents of the epidermis, forms a complex that is able to resist penetration by the pathogen.

SPREAD AND IMPORTANCE OF RICE-BLAST

The first region to become infected is the Southern Camargue, because of the prevailing high relative humidity. Next, foggy regions become infected because of the persistent humidity which is particularly high during warm nights. In that Southern Camargue region, certain rice fields are infected by 60%. It must be well-remembered that the fields which are first infected and, as a consequence, are most strongly diseased are those which were planted with Italian rice or those which were heavily fertilized with nitrogen. Fields planted with healthy French rice and which received normal amounts of nitrogen fertilizer are only lightly infected (10% maximum).

Strong attacks are produced by conidia which enter from more heavily infected adjoining fields. Diseased kernels are dangerous as seeds and useless for the rice industry because of their reduced size and chalky texture (Fig. 9).

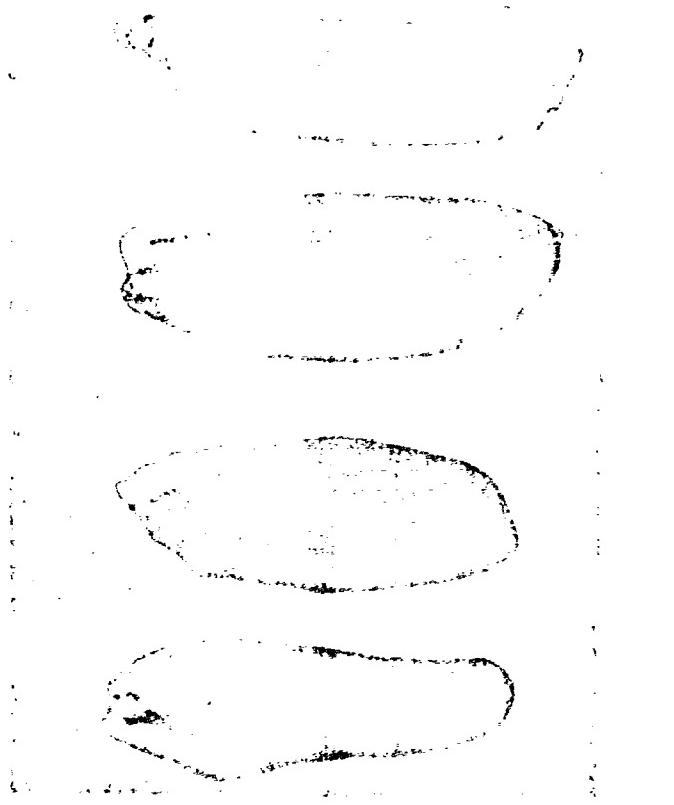


Fig. 9. Commercial rice kernels. Above: two healthy kernels.
Below: two small, deformed and chalky kernels removed from an infected panicle.

During surveys of rice fields along the Mediterranean coast of Southern France, I have made the following observations which are summarised here.

1) Agronomy

I have observed the mycelium of the mold survives in stems. It would be interesting to dry the stubble after the harvest and then to burn it, ~~and~~ the loss of nitrogen produced by this operation. The following is

not widely known: it ought to be possible to eradicate rice-blast disease by burying the straw after one inundation. Since the mold is aerobic, it ought to be destroyed by this operation. Those who hesitate to burn the stubble ought to bury it after one inundation. We believe this to be an effective method, but not as good as burning.

Weeds must also be included in these operations, especially those weeds that grow in the rice fields and on the slopes of enclosures, because they may serve as intermediate hosts for Piricularia.

2) Fertilizers

a) Nitrogen must be applied cautiously and in normal amounts, despite the tendency to increase the rate of application. From the point of view of a plant pathologist, excess nitrogen merely increases the devastation. It favors strongly the production of chlorophyll-bearing structures, while disturbing the nutritional equilibrium of the plant. On the other hand, nitrogen causes an even distribution of the disease. The creation of foci of infection in plants which are still susceptible to rice-blast is thereby avoided.

For a list of sensible uses of nitrogen (e.g. exporting, avoiding diverse losses, etc.) read the publications by Mrs. Huguet, who is in charge of research at the Agronomy Station of Avignon.

b) The vegetative parts of the rice plant are very rich in silica. Lack of silica and magnesium retards the maturing, increases the water and nitrogen contents, but also the susceptibility to rice-blast disease.

3) Better Varieties

As far as I know, there does not exist a rice variety, among varieties that interest us in France, that is totally resistant against the attacks of Piricularia. Rice varieties of Italian origin show differences in susceptibility which rice-growers, in general, learn to know from experience. This explains why variety "Maratelli," a particularly susceptible variety in the summer, has been planted less and less since 1952, despite good cultural characteristics (earliness and yield).

Buffa and Corbetta, in their most recent publications on the characteristics of rice varieties most widely cultivated in Italy, reported that variety "Rinaldo-Bersani" (R.B.) showed increased resistance against "brusone" (caused by Piricularia + Helminthosporium), while variety "Balilla" or "Ardito" has only medium resistance. Nevertheless, in all cases observed, since the epidemic of 1959, variety "R.B." is quite susceptible.

Interestingly enough, variety "Stirpe 136" is thought to be as resistant as variety "R.B.," while the oldest reports described "R.B." as being more susceptible. Since its introduction in 1937, "Stirpe 136" has

been found to be a very heterogeneous population, difficult to characterize in most aspects. It is difficult to describe its behavior in France in 1959, when "R.B." is used as a standard of comparison. Today, "Stirpe 136" is only rarely cultivated, because of its strong resistance against shelling and because the kernels are not appreciated (common category), also because of its late harvest. Deliveries to rice factories are decreasing. Nevertheless, we have reported some symptoms of rice-blast in this variety in an area very rich in nitrogen.

The Italian authors recommended to distinguish between "brusone" (caused by Piricularia + Helminthosporium) and the neck disease of the plant, caused by Piricularia only. Varieties have different susceptibility against Piricularia in their vegetative structures, especially in the neck portion of the panicle. One must really distinguish two series of symptoms of one disease, called rice-blast or piriculariosis.

Below, we present a table which summarizes the resistance of Italian varieties recorded in official French lists.

Variety	Notation of Buffa & Corbetta		Notation of the International Catalog F.A.O. '52
	Brusone (<u>Piricularia</u> + <u>Helminthosporium</u>)	Neck Disease (<u>Piricularia</u> only)	
	Resistance		
Americano 1600	medium	medium	3 strain 630
Arborio	high	high	5 " 631
Ardito (= Balilla)	medium	medium	3 " 632
Precoce Corbetta	high	high	not listed
Maratelli	medium	low	7 strain 634
Razza 77	medium	low	5 " 635
R.B.	high	medium	3 " 636
Stirpe 82	medium	low	not listed
Stirpe 136	high	medium	not listed

It would be interesting, under our climatic conditions, to perform comparative experiments on the susceptibility of varieties "Balilla", "R.B." and the new varieties introduced and grown in Crau near Le Merle. The epidemic of 1959 demonstrated that practically all rice varieties grown in France were susceptible to rice-blast.

4) Sanitary Condition of Seeds

It is obvious from all we have said, thus far, that harvested kernels, despite of their eventual use, carry many pathogens capable of spreading rice-blast.

Seed treatment is indispensable, in order to reduce the possibility of disease transmission by seed. Experiments ought to be performed to study the effect of fungicides on germination. In the meantime, even today, the use of organic-mercuric or basic thiram fungicides are recommended. Conditions for proper seed treatment will have to be worked out, especially when the fungicides are applied to the seed long before seeding.

A study of other products is less inconvenient than the approach recommended here.

On October 28, 1959, in a conversation with H. Nakamura, agronomist, Technical Services, Department of Agriculture, Japan, I learned about the methods used by Japanese rice-growers to combat rice-blast. In Japan, several fungicides are effective, especially bases of organo-mercuric compounds. The following treatments are used:

- a) seed treatments
- b) nursery treatments
- c) several treatments during the vegetative stage; their number is a function of the course of the disease.

It must be remembered, of course, climatic and meteorological conditions of the Japanese islands are entirely different from those prevailing in the Camargue. Yet, it does not seem to be necessary that this disease is here. I think it is indispensable for the control of the disease to the soil and to treat the seed.

Such techniques reduced the devastation in nurseries when Piricularia and other molds developed on young seedlings. The importance of disinfection and its effect on germination have been noted by foreign agronomists. We cite particularly recent reports by Manuel Vianna e Silva in Portugal with a translation prepared by R. Marie in the same bulletin.

Although seed treatments prevent very strong attacks, they cannot prevent the appearance of the disease in the field, especially when the pathogen enters from an adjoining, untreated field in which the wild plants harbor the pathogen.

In the meantime, it is apparent that all rice-growers ought to be interested in treating, at least, their seed, until the time when the legislature will prohibit the importation of untreated seeds into France. The situation will improve, because of the belief that the production of controlled and treated seed in France will be a measure which will satisfy all demands.

October 30, 1959.

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